tents throughout life, while the tracheides with bordered pits (transfusion tissue) contain, in the mature condition, nothing but water.

On p. 164 the statement that there is finally "free communication" between the contiguous tracheides of the wood of Pinus is erroneous. The pits are closed, at any rate as long as the wood serves its main function of conveying the sap.

At p. 171, in the same chapter, there is a repetition of Hofmeister's old mistake as to the deliquescence of the original cell-walls of the endosperm in the Conifers. Strasburger showed in his "Angiospermen und Gymnospermen," that this idea was due to Hofmeister having confused the disorganised cells of the nucellus with those of the endosperm. The Conifers have one and the same endosperm throughout the development of the ovule: there is no distinction of "primary and secondary" endosperm.

Judging from the footnote on p. 209, there seems to be some confusion between the xylem and the bundle-sheath in Trillium.

It is to be regretted that the student is not shown how to investigate the minute structure of the angiospermous embryo-sac when ready for fertilisation.

In spite of the rather serious faults noticed, the book on the whole is a good and useful one. D. H. S.

MR. MERRIFIELD'S "TREATISE ON NAUTICAL ASTRONOMY"

A Treatise on Nautical Astronomy for the Use of Students. By John Merrifield, LL.D., F.R.A.S. (London: Sampson Low, Marston, Searle, and Rivington, 1886.)

THIS is an excellent work for the student, evidently compiled with considerable care, which may also be consulted with advantage by the seaman. Of course the author does not claim originality, excepting in one particular, viz. a method of his own for "clearing the lunar distance," as, in point of fact, nearly everything the work contains has been published in previous treatises. Mr. Merrifield deserves, however, the credit of placing clearly before the student many points which are only touched on by other writers—notably the account of the correction for refraction, and the explanation of the fact that the maximum altitude is not invariably the meridian altitude, a point which is only touched on by a footnote in Raper, and is usually ignored entirely; yet which is of considerable importance in the case of the moon. The examples, also, which are given at the end of each chapter are of great use to the student, as from them a knowledge is obtained of the subjects he is likely to be examined in; and as these questions have been selected from many examination papers, they are an excellent guide. In the theoretical part of nautical astronomy the book is nearly all that can be desired, and this part can always be learnt better on shore than in a ship, where the constant noise and interruption, together with perpetual motion at sea, renders study all but impracticable: in one or two cases, however, Mr. Merrifield also touches on the practical use of instruments, &c., and on these subjects he is naturally not so good an authority. It may perhaps, therefore, be advisable to point out the usual course of proceedings in Her Majesty's surveying-vessels, both in correcting instruments and also in ascertaining positions at sea.

First, with regard to the sextant, the error of collimation is not readily obtained, as stars only are available, and there are no means of illuminating the wires in the telescope, so that a bright moonlight night is requisite. Secondly, with respect to the errors of centering and graduation, Mr. Merrifield suggests that the combined error should be ascertained by means of measuring the distance between several pairs of stars by the instruments, the correct distances having been previously calculated. But here the varying nature of the refraction prevents good results, and a better method is to measure the distances both by the sextant and by the repeating circle, as in the latter instrument all errors are eliminated.

In the account of the artificial horizon Mr. Merrifield says that "it is used for taking altitudes when the sea horizon is obscured," being apparently under the impression that it can be used on board a vessel. Were such the case, it would often relieve the mind of many an anxious navigator, but, unfortunately, the constant motion of a ship altogether precludes its use at sea; it is true that the late Capt. Becher, R.N., invented a method of observing altitudes at sea, in foggy weather, by attaching a small pendulum, suspended in oil, outside the horizon-glass of a sextant; to this a horizontal arm was fastened which carried at its inner end a slip of metal showing the true horizon when seen in a certain position; but this did not prove a success, and is now almost forgotten; and there is nothing to trust to but the compass and log when the horizon is obscured. The true use of the artificial horizon is to obtain observations on shore, and the sea horizon should never be used then. The best artificial horizon is a trough filled with mercury, covered with a glass roof, but this cannot be used in the extreme cold of the Arctic regions, and consequently there a plate of dark glass is substituted, which is adjusted by spirit levels. The error of the artificial horizon is due to two causes, first the imperfections in the glass roof, which, as Mr. Merrifield remarks, may be guarded against by reversing the roof; and secondly, owing to the attraction of mountain masses causing the mercury to depart from the true level. Could some means be found which would enable the seaman to take observations, in a vessel, independently of the sea horizon, it would be the most useful nautical discovery of the age, but this is not to be effected, as Mr. Merrifield suggests, by mounting the artificial horizon on gimbals, for even if the ship were in herself rigid, the motion at sea would preclude the possibility of obtaining observations, as the position of the observers could not be changed with sufficient rapidity to suit the ever-varying angle of reflection from the horizon, with respect to the observer on the deck; and Mr. Merrifield's own experiences of the difficulties of obtaining observations from the roof of a quiet house must have taught him that it would be much more difficult in a vessel which is constantly vibrating from the motion of the engines or other disturbing causes. The idea of placing a piece of glass on the mercury to still its vibrations, was some years ago promulgated by the late Staff-Commander George, attached to the Geographical Society, who invented a very useful little artificial horizon

for the benefit of travellers, in which the floating glass was part of the plan.

In obtaining the position of a ship at sea the difficulty is to get observations both for latitude and longitude at the same time, as all other observations depend on the distance covered by the vessel in the time which has elapsed between the observations. Now, as this distance depends not only on the direction and rate of the vessel through the water, but also on the direction and rate at which the water itself is moving, and as this latter element in the calculations cannot be ascertained with precision, it follows that all observations at sea which depend on the ship's run in the interval have an element of uncertainty. The best time to obtain simultaneous observations for latitude and longitude is at twilight, morning and evening, as then the horizon is clear, and, unless the weather is very cloudy, some stars can be seen. Here Sumner's method is invaluable, as three or more stars can be utilised and the correctness of the result guaranteed, provided, of course, that the chronometer is correct. In the day-time the only chance to obtain simultaneous observations is when the sun and moon are both visible, or when Jupiter, or Venus, happen to pass the meridian at an interval of over 2½ hours from noon, as then, in bright weather, their meridian altitudes can be obtained by a practised observer with a good sextant.

One of the difficulties in obtaining good results at sea is owing to the varying nature of the refraction, more especially close to the horizon. This may be guarded against in the case of the meridian altitude of the sun by observing, when practicable, its altitude with the north and south horizons. To show the closeness of the results ascertained in this manner, it is only necessary to observe that H.M.S. *Triton*, when fixing the position of the Ower and Lemon light-vessel on the east coast of England in 1884, obtained the latitude on four different days, the results being as follows:—

June 25	Lat.	53°	7′	56″	N.
July 9	,,	53	8	0	N.
July 11	,,	53	7	54	N.
July 12	,,	53	7	57	N.

an extreme range of 6″, or 600 feet, in the latitude. Such a close accordance shows the value of this method, which is recommended by Raper.

As regards obtaining the longitude by lunar distances, this has been gradually falling into desuetude owing to the quicker passages made by vessels and to the cheapness of chronometers. There can, however, be no doubt of its utility, as it is the only good way of obtaining the position of the ship at sea should any accident happen to the chronometers, and it is to be regretted that it is so seldom practised, particularly when we remember the excellent results obtained by the older navigators, especially by Cook. For the actual observation the repeating circle is a far better instrument than the sextant, as by it the distance between the sun and moon is observed with much greater accuracy, a matter of the utmost importance when we remember that an error of one minute in the distance makes an error of twenty-five miles of longitude under the most favourable circumstances. It is therefore evident that this observation requires to be made with the utmost care and that constant practice is necessary to obtain good results.

In the problem of obtaining the true bearing of a terrestrial object from a ship at sea, Mr. Merrifield has omitted the correction of the angular distance due to the height of the object: this is probably an accidental omission, but although it does not usually amount to much, it is desirable the student should be acquainted with it.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Laws of Solution

In my paper on "Chemical Affinity and Solution," published in NATURE, vol. xxxiii. p. 615, I gave some general proofs (taken from Thomsen's researches on thermo-chemistry) of the truth of my theory of solution. I shall now show that there are certain well-marked and definite laws of solution which are in complete accord with that theory, and seem to me to place it beyond doubt. In all chlorides, bromides, iodides, sulphates, and nitrates, for which data are available, the heats of solution in water *vary directly*—

(1) As the affinity (measured by heat of combination) of the positive element of the salt for O varies;
(2) As the affinity (measured by heat of combination) of the negative element or radicle of the salt for H varies;

And *inversely*—

As the affinity (measured as above) between the positive and negative elements of the salt varies.

The following examples will make this plain:—

Compound	Heat of combination	Difference	Heat of solution of chloride	Difference
$[Mg,Cl_2]$	151010	—	35920	—
[Mg,O,Aq]	148960	2050	—	—
$[Ca,Cl_2]$	169820	—	17410	+18510
[Ca,O,Aq]	149260	20560	—	—
		−18510	—	+18510
$[Ca,Cl_2]$	169820	—	17410	—
[Ca,O,Aq]	149260	20560	—	—
$[Sr,Cl_2]$	184550	—	11140	+6270
[Sr,O,Aq]	157780	26770	—	—
		−6210	—	+6270
$[SrCl_2]$	184550	—	11140	—
[Sr,O,Aq]	157780	26770	—	—
$[Ba,Cl_2]$	194740	—	2070	+9070
[Ba,O,Aq]	158760	35980	—	—
		−9210	—	+9070

Similar results are obtained if we substitute the alkali metals for above, but there is a variation in the case of metals which form insoluble oxides or hydrates. In the latter case the heats of solution are not so great as they should be if compared with above compounds. Among themselves, however, they follow the laws pretty closely, and seem arranged in groups. Thus, $ZnCl_2$ and $CdCl_2$, $FeCl_2$, $CoCl_2$, and $NiCl_2$ form two such groups.

The foregoing examples illustrate the effect of the change of the positive element of the salt on the heat of solution. Now let us change the negative element and we shall see the same result.